GRANDPERSPECTIVE

CAGEM: Autonomous Gas Leak Detection and Mapping of Diffuse Emissions in Large Chemical Complexes

scanfeld® monitors gas emissions in large chemical industrial sites 24/7. The scanfeld® solution uses FTIR spectroscopy for CAGEM (continuous autonomous gas emission monitoring), a technology that allows the chemical analysis and quantification of gases at distances of up to 1 km. This ability to measure at large distances makes automated monitoring of entire chemical plants feasible.

Continuous monitoring of all technical components allows the early automatic detection of small leakages. Furthermore, the mapping of leaking components and the long-term observation of leak rates makes the maintenance more plannable. Especially the detection of small leakages with an increasing leak rate is important for the prevention of unexpected spontaneous failure of components and subsequent larger gas emissions.

The scanfeld® solution is designed according to the VDI 4211 and adopts the quality standards of EPA 0000a and DIN EN 17628.

How the scanfeld® solution works: Distance monitoring for automated leak detection

The scanfeld® system is designed to notify operators automatically about a gas emission and provides information about the position of the emission source and the amount of the released gas. scanfeld® monitors all areas and components of a complex production site with just a few sensor units.

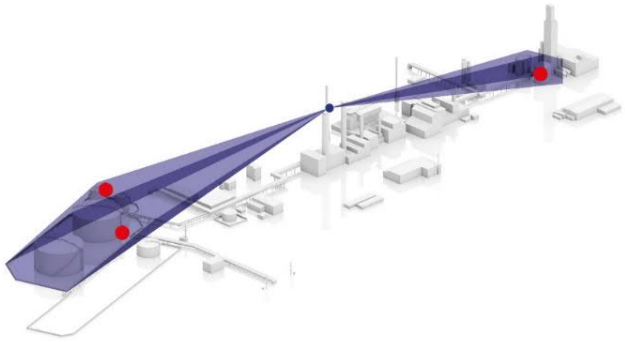

Figure 1: The remote monitoring principle: Detection and localization of gas clouds from a long distance. The optical measurement technique uses FTIR spectroscopy to identify the chemical composition in small amounts at distances up to 1 km.

The scanfeld® sensor unit works like a surveillance camera for gases. The sensor units continuously scan predefined areas-of-interest (‘*scan areas*’) automatically 24/7. Flexible automatic positioning in all 360°/+-90° and scanning at variable speed allows the coverage of the entire critical infrastructure.

Figure 2: The scanfeld® sensor unit in a chemical park. In this installation two sensors monitor four production facilities. The sensor units have flexible scan ranges in 360°. The monitoring solution works autonomously 24/7.

All scan areas are simultaneously displayed in a multi-view user interface. The user interface warns the operator of gas emissions and displays the gas cloud in real-time. Once the user has been provided with an alert on the user interface, there are several functions which provide additional information about the chemical composition of the gas, the amount of gas, and the duration of the event. Color coded alert signals in the user interface provide an intuitive situation assessment.

Figure 3: Data example of eight scan areas of a production site. The scan areas are sequentially scanned and displayed in a multi-view user interface.

The sensor units use the optical measurement technology FTIR spectroscopy: A chemical analysis method that operates in the mid-infrared spectral region. Spectroscopy has the highest information depth per sample over all comparable distance measurement techniques. In effect the identification of a gas is highly reliable. The solution is robust against false identifications, influence of water vapor, dust, or cross sensitivity from other technical gases.

Autonomous monitoring: Real-time gas leak warning and LDAR leak mapping of diffuse emissions

scanfeld® is an intelligent and highly automated monitoring solution. It continuously watches out for fugitive and non-fugitive gas emissions. Real-time modules quickly alert the operator for large gas emissions. Automatic in-depth analysis of the measurement data identifies small leaks. The measured data is aggregated to achieve a precise leak source localization and the detection of smallest leaks. Auto-generated reports provide insight into safety and integrity of the plant.

Autonomous monitoring for leak detection

Diffuse emissions are not released from a specific emission point (e.g. a stack), the term rather describes all unchanneled emissions from other sources. Diffuse emissions include both fugitive and non-fugitive emissions. Fugitive emissions are spontaneous and non-persistent and stem from venting, relaxation, damage of sealing elements, or failure of equipment. Non-fugitive emissions can occur from leakages, wastewater treatment, open vents, etc.

Detecting diffuse emissions in a chemical plant is possible with continuous autonomous gas emission monitoring. It is a spectroscopic gas analysis and imaging method which is carried out continuously and without the need for personnel. This top-down approach to continuously monitor all areas of critical infrastructure is superior to the bottom-up approach of element-wise manual inspection. It covers more components than routine inspections with much higher frequency. Leaks and fugitive emissions are detected much faster. Furthermore, the autonomous permanent monitoring covers not only all components where one might expect a leak, it also covers all areas where a leak might appear unexpected.

Real-time warning

The real-time warning module of the scanfeld® solution picks up gas releases that are unusual. This automatic classification of the situation is derived from the amount of gas in the air and separates a hazardous gas leak scenario from small and fugitive technical emissions. This real-time monitoring is a fast automatic safety feature for the early warning for gas leaks. In the user interface gas clouds are mapped instantly. Alarm signals are displayed and can be provided to the DCS (PLS) of the plant. It also helps post-release safety procedures involving third parties (for example, health and safety inspectors or firefighters) with information about the total amount of the released gas and the location of the gas cloud.

➔ *For details on our real-time warning modules see the whitepaper scanfeld® profiler.*

The automatic leak detection LDAR inspection

The automatic long-term in-depth analysis is a leak detection and mapping method. All components in the scan areas are permanently monitored. It is an autonomous gas emission monitoring method.

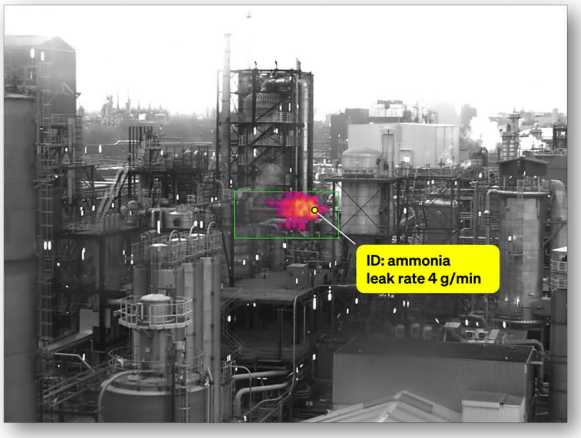

Figure 4: Detection of small leaks in a production facility at 200 m distance.

The method is taking advantage of the permanent setup of the scanfeld® solution. Each point within the scan areas is repeatedly scanned and thus continuously monitored. From the analysis of large datasets, even small amounts of gas become visible, so emission spots can easily be pinpointed. The method isolates persistent emission spots from varying technical emissions, fugitive emissions and other sources. Effectively, this method localizes the sources of diffuse emissions.

Automatic scanning of all components is scheduled and performed in regular LDAR inspection cycles. The inspection intervals can be anything between a couple of months to daily inspections. Every inspection cycle generates an optional report, which lists all detected leakages and their locations. Further reports are generated automatically at periodic intervals and list all diffuse emissions and the calculated flow rates of the emissions. For fugitive emissions the total mass of the released gas is calculated.

Data integration

The IT integration of the autonomous scanfeld® monitoring solution was developed in cooperation with chemical industry partners. The monitoring solution is run on on-premises hardware that is protected against power failures. The user interface for the control room is provided within a designated network and can be shared between the control room and field operators on hand-held devices.

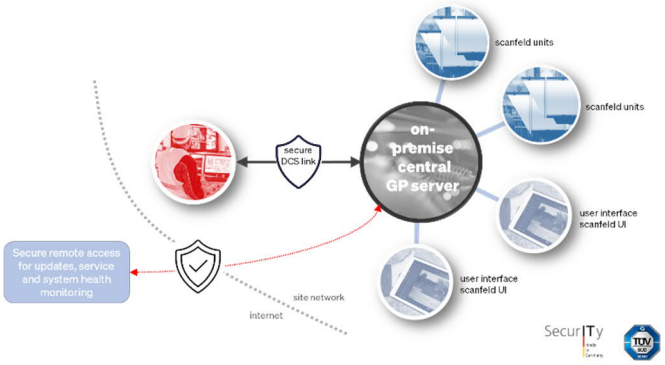

Figure 5: The IT concept is centered around the secure on-premises installation of the sensor units and a local server. The user interface is provided within a designated network for all devices. Secure DCS connection and secure remote maintenance access are provided.

The real-time warning module generates data sets with warning levels and gas concentration information from freely definable locations – like a network of virtual gas sensors. Information derived from the automatic in-depth analysis provides additional data. All data streams can be integrated into the Distributed Control System (DCS) or Process Control System (PCS) of the chemical plant to make all relevant information and warning events easily available. The implementation of the user interface into the plant's operating system is securely facilitated by an OPC Unified Architecture (OPC-UA) provided by the scanfeld® system. It is also possible to interface by other standards or to add additional security layers by using secure broker services.

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